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IS : 5503 ( Part I ) - 1969

*Indian Standard*

GENERAL REQUIREMENTS FOR  
SILOS FOR GRAIN STORAGE

PART I CONSTRUCTIONAL REQUIREMENTS

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INDIAN STANDARDS INSTITUTION  
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG  
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# Indian Standard

## GENERAL REQUIREMENTS FOR SILOS FOR GRAIN STORAGE

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(Continued on page 2)

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# IS : 5503 ( Part I ) - 1969

( Continued from page 1 )

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( Continued on page 12 )

*Indian Standard*  
**GENERAL REQUIREMENTS FOR  
SILOS FOR GRAIN STORAGE  
PART I CONSTRUCTIONAL REQUIREMENTS**

**0. FOREWORD**

**0.1** This Indian Standard ( Part I ) was adopted by the Indian Standards Institution on 22 December 1969, after the draft finalized by the Storage and Marketing Structures for Agricultural Commodities Sectional Committee had been approved by the Agricultural and Food Products Division Council.

**0.2** In India, agriculture contributes nearly 50 percent of total national income and of which food grains are the most important. There is a huge loss of food grains in storage. The loss can be minimized by scientific storage and by employing proper storage structures which can protect the grain from rodents, insect pests and outside humidity and temperature.

**0.3** For the purpose of handling, transporting and storage of large quantities of food grains in bulk, special storage structures are required. Such structures are needed where:

- a) grains from producers are collected at a central shipping point,
- b) grains are brought and stored to be used by the processing or manufacturing plants,
- c) grains are stored for transferring from one vessel to another or to railway wagons, and
- d) grain exporting and importing ports.

Accordingly, these are named as interior storage silos, mill silos, transfer silos and sea-board silos respectively. This standard primarily applies to the storage and sea-board silos.

**0.4** This standard is a necessary adjunct to IS: 5503 ( Part II )-1969 ' General requirements for silos for grain storage: Part II Grain handling equipment and accessories '.

**0.5** This code is not intended to restrict the initiative and ingenuity of diseng and construction engineers.

**0.6** For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance

## IS : 5503 ( Part I ) - 1969

with IS : 2-1960\*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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### 1. SCOPE

**1.1** This standard ( Part I ) prescribes the basic constructional requirements for steel and reinforced cement concrete silos.

**1.2** This standard primarily applies to the storage and sea-board silos.

### 2. TERMINOLOGY

**2.0** For the purpose of this standard, the following definitions shall apply.

**2.1 Grains** — All cereals, pulses, millets, milled products, oilseeds and the grain intended to be used as seed.

**2.2 Silo** — A unit consisting of several tall bins having height greater than their diameter used for storage and handling of grains in bulk and fitted with necessary equipment and accessories.

**2.3 Storage Block** — A portion of the silo used for the storage of grain.

**2.4 Headhouse** — A portion of the silo which houses elevator and other accessories, such as weighing and cleaning machines for grains.

**2.5 Distribution Gallery** — The structure on top of bins for housing conveyor system for distribution of grain into bins.

**2.6 Marine Tower** — A structure located on the quay side for either loading or unloading of food grains into and from ships. This may be stationary or portable.

**2.7 Collection Gallery** — A portion of the silo at or below ground level for housing collection equipment.

**2.8 Angle of Repose** — An angle formed with the horizontal plane, at which the loose grain, when piled, will retain its position.

**2.9 Garner** — An intermediate hopper for storage of grains to ensure desired flow for further handling of grains.

### 3. LOCATION

**3.1** The structure shall be located on a site having proper drainage and not liable to flooding or inundations, and which has adequate load bearing capacity.

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\*Rules for rounding off numerical values ( revised ).



**3.2** The structure, as far as possible, shall be well away from source of contamination, such as slaughter-house and tanneries, and possible sources of fire-hazard, such as timber stores and petrol pumping stations.

**3.3** The construction of structure in residential areas shall be avoided.

**3.4** Silos, as far as possible, shall be located near railheads. There shall be loading and unloading facilities and sufficient space for manoeuvring vehicles and railway line. Where silo is near water-ways, such as docks and ferry heads, sufficient berthing, loading and unloading facilities shall be made available.

**3.5** Silos shall be located with due regard to the maximum possible expansion facilities.

**3.6** In case the location is near air-port, necessary permission shall be obtained from the aviation authorities.

#### **4. SILO AND ANCILLARY STRUCTURES**

**4.1** A silo shall generally consist of truck and wagon dump or both, head-house, storage block, and distribution and collection galleries ( *see* Fig. 1 ). Besides, it may have a number of ancillary structures at each site, such as a small block consisting of office and store rooms, a laboratory, a non-combustible store-building for storing fuels, a bagging shed, a track shed where the wagons or lorries may be handled under cover, repair shop, weigh bridges for lorries and wagons, an electrical substation, and a control room.

#### **5. TRUCK OR WAGON DUMP**

**5.1** Truck dump shall consist of a single hopper or series of hoppers where the grain is dumped by trucks, wagons or carts.

**5.2** Truck dump shall be generally located near the headhouse by the side of a road.

**5.3** Wagon dump shall be located near the headhouse by the side of a railway track.

**5.4** Truck dump and wagon dump shall be adequately protected against rain and shall be provided with suitable metal sieves with sufficient strength for separation of foreign matter, such as hay or other bigger sized grains.

**5.5** The hopper may be made of steel with suitable slope for easy flow of the grains.

**5.6** The dump shall have adequate provision for drainage in case of water accumulation.

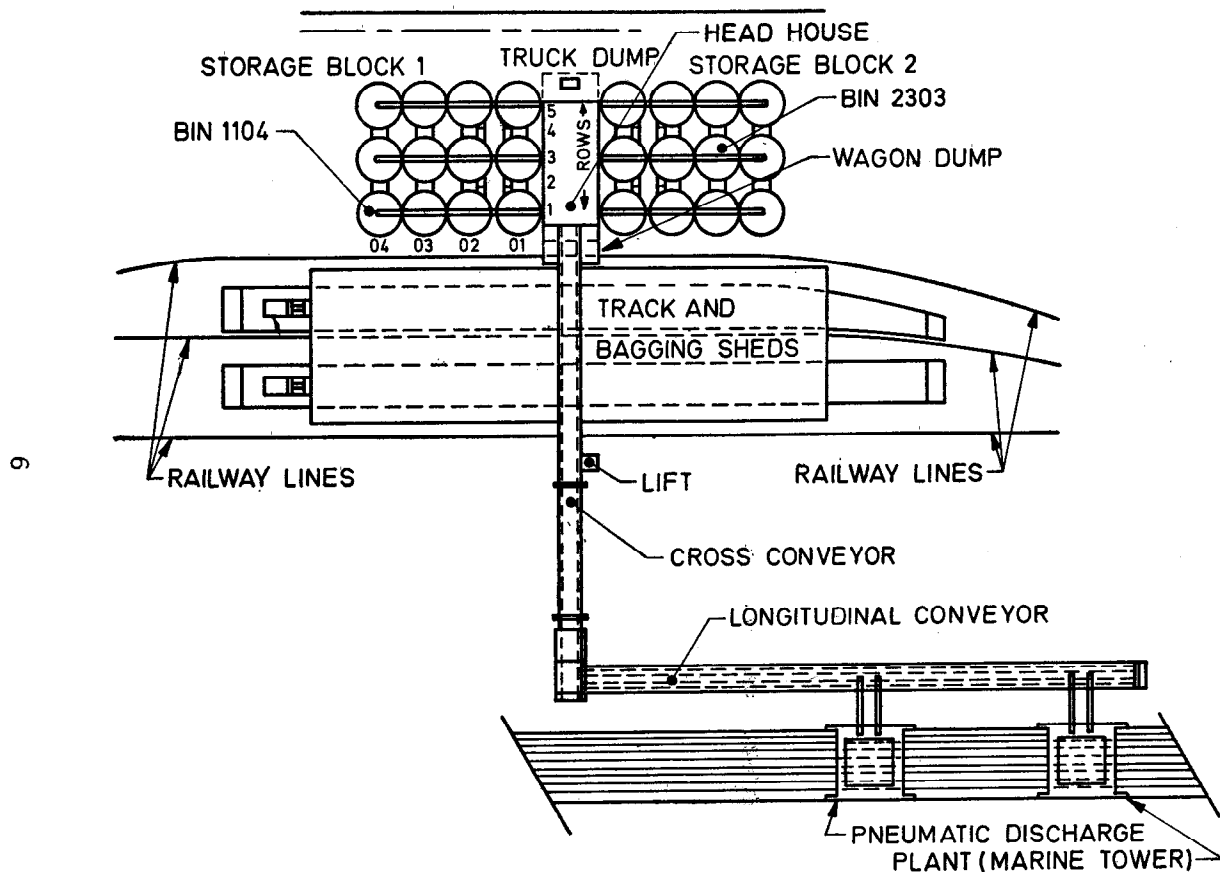


FIG. 1 GENERAL LAYOUT PLAN FOR A GRAIN SILO

## 6. HEADHOUSE

**6.1** A headhouse shall consist of basement and a number of floors. It shall accommodate chiefly the bucket elevators for vertical elevation of grains, automatic weighing and cleaning machines, garners and other handling equipment.

**6.2** The height of the headhouse shall be determined by the height of the elevators. The top floor shall accommodate driving equipment of the bucket elevators.

**6.3** The various floors of headhouse shall be designed for actual loads due to various types of machines installed plus 400 kg/m<sup>2</sup>. For preliminary design purposes, in the absence of details of actual loads of the equipment, the loads given in Table 1 may be adopted.

**TABLE 1 LOADS FOR PRELIMINARY DESIGN OF DIFFERENT FLOORS OF HEADHOUSE**

( Clauses 6.3 and 8.3 )

SL No.	FLOORS OF HEADHOUSE	LOADS IN kg/m <sup>2</sup> FOR RATED CAPACITY OF HANDLING EQUIPMENT			
		Up to 100 t/h	101-500 t/h	500-1 000 t/h	Above 1 000 t/h
(1)	(2)	(3)	(4)	(5)	(6)
i)	Top floor ( accommodating the driving equipment of bucket elevator )	500	750	1 000	1 200
ii)	Despatch conveyor floor	500	650	750	1 000
iii)	Scale floor	500	750	1 000	1 200
iv)	Distribution floor	500	750	1 000	1 200
v)	Cleaner floor	500	650	750	1 000

**6.4** The structural provisions, such as necessary openings and supports for various equipment [ see IS : 5503 ( Part II )-1969\* ] shall be provided for in the design of the headhouse.

**6.5** In case the silo is situated near airways, suitable obstruction markings shall be provided on the headhouse in accordance with the existing Civil Aviation Standards.

**6.6** The headhouse may be of reinforced cement concrete or steel construction.

\*General requirements for silos for grain storage : Part II Grain handling equipment and accessories.

**6.7** The basement shall be of sufficient depth to receive the grains from the collection conveyors and of adequate dimensions to accommodate the truck or wagon dump, the boot of the elevator, and conveyor equipment.

**6.8** The basement shall be waterproof.

## **7. STORAGE BLOCK**

**7.0** The storage block shall consist of a number of storage bins which receive the grain from the headhouse through the distribution gallery.

**7.1 Storage Bins** — The silo bins may be circular, rectangular or of any other shape. The dimensions of the bins shall be decided by considerations, such as load bearing capacity of the soil, quantity and variety of food grains to be handled, workable height of a bucket elevator, and stresses induced by grains, wind and seismic loads. The bins may be constructed of reinforced cement concrete or of steel.

**7.1.1** The circular bins shall be constructed with the following dimensions:

	<i>Min</i>	<i>Max</i>
Diameter in metres	8	10
Height in metres	40	50

NOTE — Silo bins with smaller dimensions than those specified above and silos with lesser overall capacity than 50 000 tonnes have been proved to be uneconomical and hence are not recommended.

**7.1.2 Arrangement** — The silo bins may preferably be arranged in rows (not exceeding four rows) with the headhouse located in a convenient position. The interspaces between the bins may also be used for storage purposes. The general plans of a typical silo structure are given in Fig. 1 for guidance only.

**7.1.2.1** The rows of bins shall be uniformly numbered according to the system described below and shown in Fig. 1, to facilitate easy identification and management:

- Facing headhouse from track line, storage block on the left shall be numbered as Block 1 and on the right side as Block 2.
- The rows of bins, including rows of star bins or interspace bins, shall be serially numbered as 1, 2, 3, 4, ....., etc, starting from the track side. Even if the interspace bins are not utilized, these shall be assigned numbers according to the plan.
- The bins shall be numbered as No. 01, 02, ....., etc, starting from the headhouse. Thus, bin No. 1104 will indicate the fourth bin in the first row in the left block.

**7.1.3 Criteria for Design of RCC Bins** — The criteria for design of RCC bins shall be as given in IS : 4995-1968\*.

**7.1.4 Criteria for Design of Steel Bins** — The criteria for design of steel bins shall be as given in 'Indian Standard code of practice for design, fabrication and erection of steel silos and bunkers'. (*under preparation, see Note*).

NOTE — Until this standard is published, this criteria shall be as agreed to between the concerned parties.

**7.2 Foundation** — The silo structure shall rest on reinforced cement concrete raft foundation supported on piles or laid directly on soil, depending on the soil condition. In any case, site investigations for foundation shall be carried out (*see* IS : 1892-1962†).

**7.2.1** While laying down the foundation, due consideration shall be given to the wind forces (*see* IS : 875-1964‡) and seismic conditions of the zone (*see* IS : 1893-1966§).

**7.2.2** In case the reinforced cement concrete raft is to be laid over the piles, the top of the mat shall be at the plinth level.

**7.2.3** The type of foundation for the storage bins shall be decided taking into account the layout, nature of soil and the loads transferred.

**7.3 Plinth** — The concrete mat on which the silo bins stand shall be deemed as the plinth, unless the mat is laid directly on hard soil or rock. In the latter case, suitable plinth walls shall be provided outside with masonry work and the space between the reinforced cement concrete mat and the hopper of the silos shall be used for housing the collection conveyors.

**7.3.1** The plinth level shall be at least 0.5 m higher than the maximum rain water level.

**7.4 Other Requirements** — The requirements for floors, walls, roofs and bin bottoms of the reinforced cement concrete bins shall be as given in IS : 4995-1968\*. In case of the steel bins, the requirements shall be as given in 7.4.1 to 7.4.4 [*see also* 'Indian Standard code of practice for design, fabrication and erection of steel silos and bunkers' (*under preparation*) ].

\*Criteria for design of reinforced concrete bins (silos) for bulk food grain storage.

†Code of practice for site investigations for foundations.

‡Code of practice for structural safety of buildings : Loading standards.

§Criteria for earthquake resistant design of structures (*first revision*).

**7.4.1 Floor**

**7.4.1.1** Basement floors shall be of reinforced cement concrete and properly waterproofed.

**7.4.1.2** The side walls shall also be waterproofed.

**7.4.2 Walls**

**7.4.2.1** The exterior surface of the walls shall be given suitable water-proofing treatment.

**7.4.2.2** The walls shall preferably be painted with aluminium paint from outside.

**7.4.3 Roof**

**7.4.3.1** The roof over the silos shall be waterproofed. It shall be laid giving a suitable slope for proper drainage of rain water.

**7.4.3.2** Suitable air-tight openings for spouting, aeration, fumigation, etc, shall be provided for in the design of the roof.

**7.4.4 Bin Bottom**

**7.4.4.1** The bins shall be provided with flat or hopper bottom. In case of hopper bottom, the slope adopted shall be suitable for material to be handled and the material of the hopper to ensure easy gravity flow. It shall be at least 10 deg more than the angle of repose.

**7.4.4.2** Suitable air-tight openings for discharge of grains, aeration, fumigation, etc, shall be provided for in the design of bin bottom.

**8. GALLERIES**

**8.1 Distribution Gallery** — Distribution gallery shall accommodate the conveying equipment for receipt of grains from the distribution elevators of the head house for spouting to the various bins.

**8.1.1 Dimensions** — The type and number of galleries and their dimensions shall depend upon the number of conveyors to be housed and the rows of bins. While designing the gallery, care shall be taken to provide sufficient space for distribution arrangement, dust control equipment, and for inspection and maintenance.

**8.2 Collection Gallery** — It shall house the conveying equipment for receipt of grains from the bins and shall be located below the bins. The type and number of galleries and their dimensions shall depend upon the number of conveyors to be housed and the rows of bins. While designing the gallery, care should be taken to provide sufficient space for distribution arrangement, dust control equipment, and for inspection and maintenance.

**8.3** The loads for preliminary design of galleries shall be adopted as given in Table 1. The actual load of mechanical equipment plus 400 kg/m<sup>2</sup> shall be adopted for design of galleries.

## **9. ANCILLARY STRUCTURES**

**9.1 Track Shed** — The track shed shall be separated from the headhouse by a fire-proof and dust-proof partition.

**9.1.1** Fixed glass windows shall be provided in the partition.

**9.1.2** The doors in the partition shall be self-closing.

## **9.2 Bagging Shed**

**9.2.1** The bagging shed shall be so located as to facilitate receipt of bulk grains from the headhouse and despatch of bags by trucks or rail cars.

**9.2.2** It shall also be rodent-proof and fire-proof.

## **10. GENERAL REQUIREMENTS**

### **10.1 Doors and Windows**

**10.1.1** Doors and windows shall be of non-combustible material.

**10.1.2** Adequate doorways shall be provided in the basement and in the gallery floor for easy access to fire-escape exits in case of emergency.

### **10.2 Stairways and Exits**

**10.2.1** Stairways shall have an easy slope and shall be provided with suitable landings at intervals.

**10.2.2** Stairways, required for exit purpose and passenger lifts, shall be in shafts formed of non-combustible material.

**10.2.3** Openings in the stairways shall have self-closing shutters hinged to open in the direction of exit.

**10.2.4** At least two exit doors, as remote from one another as practicable, shall be provided in the basement and preferably in each floor.

**10.2.5** A separate fire escape ladder shall be provided from the gallery floor and from the headhouse.

**10.2.5.1** The fire escape ladder shall be provided with suitable protection caging.

**10.2.5.2** The fire escape ladder shall be easily accessible.

**10.3 Ventilation** — Ventilation for the buildings, operating rooms and for the areas, where protection for explosion is necessary, shall be as permitted by the factory regulations in force.

**10.3.1** In the case of basements, the venting area shall be the maximum, that is practicable consistent with stability.

**10.3.2** Wired glass may be used only as protection against explosions and, where it is included in explosion-venting areas, explosion-type hardware shall be used.

## IS : 5503 ( Part I ) - 1969

( Continued from page 2 )

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